AMENDMENTS TO THE CLAIMS

This listing of claims will replace all prior versions and listings of claims in the application:

1. (Currently Amended) An objective lens used for an optical pickup device, ~~wherein~~ the optical pickup device ~~comprises~~ comprising:

a light source; and

a converging optical system including the objective lens for converging a light beam emitted from the light source to an information recording surface of an optical information recording medium, [[and]]

wherein the optical pickup device is capable of recording and/or reproducing information by converging the light beam emitted from the light source to the information recording surface of the optical information recording medium with the converging optical system, and

wherein the objective lens is a plastic single lens and satisfies following formulas:

$$NA \geq 0.8 \quad (1)$$

$$1.0 > f > 0.2 \quad (2)$$

$$\underline{0.8 < d/f < 1.8} \quad \underline{(14)}$$

$$\underline{500 \geq \lambda_0 \geq 350} \quad \underline{(15)}$$

$$\underline{0.40 \leq (X1 - X2)\cdot(N - 1)/(NA\cdot f\cdot\sqrt{(1 + |m|)}) \leq 0.63} \quad \underline{(16)}$$

where NA is an image-side numerical aperture of the objective lens, which is required for recording and/or reproducing information to the optical information recording medium, [[and]] f (mm) is a focal length of the objective lens, λ_0 (nm) is a

design wavelength of the objective lens, d (mm) is a lens thickness in an optical axis of the objective lens, X1 (mm) is a distance in an optical axis direction between a plane that is perpendicular to an optical axis and tangent to a top of an optical surface on a light source side and an optical surface on the light source side in a most peripheral portion of an effective diameter (position of the NA on a surface on the light source side to which a marginal light beam is incident), X2 (mm) is a distance in an optical axis direction between a plane that is perpendicular to an optical axis and tangent to a top of an optical surface on an optical information recording medium side and an optical surface on the optical information recording medium side in a most peripheral portion of an effective diameter (position of the NA on a surface on the optical information recording medium side to which a marginal light beam is incident), N is a refractive index of the objective lens at the design wavelength λ_0, and m is an image formation magnification of the objective lens,

wherein X1 is a plus in a case of measuring X1 in a direction of the optical information recording medium with reference to the tangent plane, and minus in a case of measuring X1 in a direction of the light source, and

wherein X2 is plus in a case of measuring X2 in a direction of the optical information recording medium with reference to the tangent plane and minus in a case of measuring X2 in a direction of the light source.

2. (Currently Amended) The objective lens for the optical pickup device of claim 1, wherein ~~in case that~~ $W(\lambda_0, T_0)$ is an RMS value of residual aberration of the objective lens when light having a wavelength of λ_0 (nm), which is a design wavelength

thereof, is incident to the objective lens at an environmental temperature, which is a first ambient temperature $T_0 = 25$ °C, and

wherein $W(\lambda_0, T_1)$ is an RMS value of residual aberration of the objective lens when light having the wavelength of λ_0 (nm), which is a design wavelength thereof, is incident to the objective lens at the environmental temperature, which is a second ambient temperature $T_1 = 55$ °C,

ΔW defined by

$$\Delta W = |W(\lambda_0, T_1) - W(\lambda_0, T_0)| \quad (3)$$

satisfies a following formula:

$$\Delta W < 0.035\ \lambda rms \quad (4)$$

3. (Currently Amended) The objective lens for the optical pickup device of claim 1, wherein the design wavelength λ_0 of the optical objective lens is not more than 500 nm,

~~and in case that~~ wherein $fB(\lambda_0, T_0)$ is a back focal length of the objective lens when light having a wavelength of λ_0 (nm) is incident to the objective lens at an environmental temperature, which is a first ambient temperature $T_0 = 25$ °C, and

wherein $fB(\lambda_1, T_0)$ is a back focal length of the objective lens when light having a wavelength of λ_1 (nm), which is 5 nm longer than the wavelength of λ_0, is incident to the objective lens at the environmental temperature, which is the first ambient temperature $T_0 = 25$ °C,

ΔfB defined by

$$\Delta fB = |fB(\lambda_1, T_0) - fB(\lambda_0, T_0)| \quad (5)$$

satisfies a following formula:

$$\Delta fB < 0.001 \text{ mm} \quad (6)$$

4. (Previously Presented) The objective lens for the optical pickup device of claim 1, wherein the objective lens is an objective lens of a finite conjugate type for converging a diverging light beam emitted from the light source to the information recording surface of the optical information recording medium and satisfies a following formula:

$$0.8 > f > 0.2 \quad (6A)$$

5. (Original) The objective lens for the optical pickup device of claim 4, wherein m satisfies a following formula when m is an image formation magnification of the objective lens:

$$0.2 > |m| > 0.02 \quad (6B)$$

6. (Currently Amended) An objective lens used for an optical pickup device, ~~wherein~~ the optical pickup device ~~comprises~~ <u>comprising:</u>

a light source; and

a converging optical system including [[an]] <u>the</u> objective lens for converging a light beam emitted from the light source to an information recording surface of an optical information recording medium, [[and]]

wherein the optical pickup device is capable of recording and/or reproducing information by converging the light beam emitted from the light source to the information recording surface of the optical information recording medium with the converging optical system,

wherein the objective lens is a plastic single lens that comprises a ring-shaped phase structure on at least one optical surface, the ring-shaped phase structure comprising a plurality of ring surfaces and formed so that adjacent ring surfaces generate a predetermined optical path difference for incident light, and satisfies following formulas:

$$NA \geq 0.8 \qquad (7)$$

$$1.3 > f > 0.2 \qquad (8)$$

$$0.8 < d/f < 1.8 \qquad (14)$$

$$500 \geq \lambda_0 \geq 350 \qquad (15)$$

$$0.40 \leq (X1 - X2)\cdot(N - 1)/(NA\cdot f\cdot\sqrt{(1 + |m|)}) \leq 0.63 \qquad (16)$$

where NA is an image-side numerical aperture of the objective lens, which is required for recording and/or reproducing information for the optical information recording medium, [[and]] f (mm) is a focal length of the objective lens, λ_0 (nm) is a design wavelength of the objective lens, d(mm) is a lens thickness in an optical axis of the objective lens, X1 (mm) is a distance in an optical axis direction between a plane that is perpendicular to an optical axis and tangent to a top of an optical surface on a light source side and an optical surface on the light source side in a most peripheral portion of an effective diameter (position of the NA on a surface on the light source side to which a marginal light beam is incident), X2 (mm) is a distance in an optical axis

direction between a plane that is perpendicular to an optical axis and tangent to a top of an optical surface on an optical information recording medium side and an optical surface on the optical information recording medium side in a most peripheral portion of an effective diameter (position of the NA on a surface on the optical information recording medium side to which a marginal light beam is incident), N is a refractive index of the objective lens at the design wavelength λ_0, and m is an image formation magnification of the objective lens,

wherein X1 is a plus in a case of measuring X1 in a direction of the optical information recording medium with reference to the tangent plane, and minus in a case of measuring X1 in a direction of the light source, and

wherein X2 is plus in a case of measuring X2 in a direction of the optical information recording medium with reference to the tangent plane and minus in a case of measuring X2 in a direction of the light source.

7. (Currently Amended) The objective lens for the optical pickup device of claim 6, wherein the ring-shaped phase structure is a diffraction structure having a function for diffracting predetermined incident light, and the objective lens ~~forms a converging wave front which is converged on the information recording surface owing to an effect obtained by combining a diffraction effect and a refraction effect~~ has a spherical aberration characteristic that spherical aberration changes in an undercorrected direction when a wavelength of the incident light changes to a longer wavelength.

8. (Cancelled)

9. (Currently Amended) The objective lens for the optical pickup device of claim 7, wherein [[when]] an optical path difference added to a wave front transmitted through the diffraction structure is denoted by an optical path difference function Φ_b defined by

$$\Phi_b = b_2 \cdot h^2 + b_4 \cdot h^4 + b_6 \cdot h^6 + \ldots$$

(wherein b_2, b_4, b_6... are 2nd-order, 4th-order, 6th-order... optical path difference function coefficients, respectively), a following formula is satisfied:

$$-70 < (b_4 \cdot h_{MAX}^4)/(f \cdot \lambda_0 \cdot 10^{-6} \cdot (NA \cdot (1-m))^4) < -20 \qquad (8A)$$

wherein λ_0 (nm) is a design wavelength of the objective lens, h_{MAX} is an effective diameter maximum height (mm) of the optical surface on which the diffraction structure is formed, and m is an image formation magnification of the objective lens.

10. (Cancelled)

11. (Currently Amended) The objective lens for the optical pickup device of claim [[10]] 6, wherein when a ring surface including an optical axis is called a central ring surface, a ring surface adjacent to an outside of the central ring surface is formed to be displaced in the optical axis direction so as to have a shorter optical path length than the central ring surface, and a ring surface at a maximum effective diameter position is formed to be displaced in the optical axis direction so as to have a longer optical path length than an ring surface adjacent to an inside thereof~~, and a ring surface at a position~~

~~of 75% of a maximum effective diameter is formed to be displaced so as to have a shorter optical path length than a ring surface adjacent to an inside thereof and a ring surface adjacent to an outside thereof~~.

12. (Currently Amended) The objective lens for the optical pickup device of claim [[10]] 11, wherein a total of the ring surfaces is from 3 to 20.

13. (Currently Amended) The objective lens for the optical pickup device of claim [[10]] 11, wherein when Δ_j (μm) is a step amount of an arbitrary step of steps in the optical axis direction at a boundary of mutually adjacent ring surfaces in a ring-shaped phase structure formed in a region from a height of 75% to a height of 100% of an effective diameter maximum height of the optical surface on which the ring-shaped phase structure is formed and n is a refractive index of the objective lens at a design wavelength of λ_0 (nm), m_j represented by

$$m_j = INT(X) \qquad (8B)$$

(wherein $X = \Delta_j \cdot (n-1)/(\lambda_0 \cdot 10^{-3})$ and INT(X) is an integer obtained by half adjust of [[(X)]] X and is an integer not less than 2.

14. (Currently Amended) The objective lens for the optical pickup device of claim 6, wherein ~~in case that~~ $W(\lambda_0, T_0)$ is an RMS value of residual aberration of the objective lens when light having a wavelength of λ_0 (nm), which is a design wavelength

thereof, is incident to the objective lens at an environmental temperature, which is a first ambient temperature T_0 = 25 °C,

wherein $W(\lambda_1, T_0)$ is an RMS value of residual aberration of the objective lens when light having a wavelength of λ_1 (nm), which is 5 nm longer than the wavelength of λ_0, is incident to the objective lens at the environmental temperature, which is the first ambient temperature T_0 = 25 °C, and

wherein $W(\lambda_2, T_1)$ is an RMS value of residual aberration of the objective lens when light having a wavelength of λ_2 (nm) is incident to the objective lens at the environmental temperature, which is a second ambient temperature T_1 = 55 °C,

$\Delta W1$ and $\Delta W2$ defined by

$$\Delta W1 = |W(\lambda_2, T_1) - W(\lambda_0, T_0)| \quad (9)$$

$$\Delta W2 = |W(\lambda_1, T_0) - W(\lambda_0, T_0)| \quad (10)$$

satisfy following formulas:

$$\Delta W1 < 0.035\ \lambda\text{rms} \quad (11)$$

$$\Delta W2 < 0.035\ \lambda\text{rms} \quad (12)$$

wherein

when $\lambda_0 < 600$ nm, $\lambda_2 = \lambda_0 + 1.5$ (nm), and

when $\lambda_0 \geq 600$ nm, $\lambda_2 = \lambda_0 + 6$ (nm).

15. (Original) The objective lens for the optical pickup device of claim 14, wherein the objective lens satisfies a following formula:

$$\sqrt{((\Delta W1)^2 + (\Delta W2)^2)} < 0.05\ \lambda\text{rms} \quad (13)$$

16. (Previously Presented) The objective lens for the optical pickup device of claim 6, wherein the objective lens is an objective lens of a finite conjugate type for converging a diverging light beam emitted from the light source on the information recording surface and satisfies a following formula:

$$1.1 > f > 0.2 \qquad (13A)$$

17. (Original) The objective lens for the optical pickup device of claim 16, satisfying a following formula when m is an image formation magnification of the objective lens:

$$0.2 > |m| > 0.02 \qquad (13B)$$

18-20. (Cancelled)

21. (Currently Amended) An optical pickup device, comprising:

a light source; and

a converging optical system including an objective lens for converging a light beam emitted from the light source to an information recording surface of an optical information recording medium, [[and]]

wherein the optical pickup device is capable of recording and/or reproducing information by converging the light beam emitted from the light source to the information recording surface of the optical information recording medium with the converging optical system,

wherein the objective lens is a plastic single lens and satisfies following formulas:

$$NA \geq 0.8 \qquad (1)$$

$$1.0 > f > 0.2 \qquad (2)$$

$$500 \geq \lambda_0 \geq 350 \qquad (15)$$

where NA is an image-side numerical aperture of the objective lens, which is required for recording and/or reproducing information to the optical information recording medium, [[and]] f (mm) is a focal length of the objective lens, and λ_0 (nm) is a design wavelength of the objective lens,

wherein the optical device satisfies the following formulas:

$$0.8 < d/f < 1.8 \qquad (14)$$

$$0.40 \leq (X1 - X2)\cdot(N - 1)/(NA\cdot f\cdot\sqrt{(1 + |m|)}) \leq 0.63 \qquad (16)$$

where d (mm) is a lens thickness in an optical axis of the objective lens, X1 (mm) is a distance in an optical axis direction between a plane that is perpendicular to an optical axis and tangent to a top of an optical surface on a light source side and an optical surface on the light source side in a most peripheral portion of an effective diameter (position of the NA on a surface on the light source side to which a marginal light beam is incident), X2 (mm) is a distance in an optical axis direction between a plane that is perpendicular to an optical axis and tangent to a top of an optical surface on an optical information recording medium side and an optical surface on the optical information recording medium side in a most peripheral portion of an effective diameter (position of the NA on a surface on the optical information recording medium side to which a marginal light beam is incident), N is a refractive index of the objective lens at

the design wavelength λ_0, and m is an image formation magnification of the objective lens,

wherein X1 is a plus in a case of measuring X1 in a direction of the optical information recording medium with reference to the tangent plane, and minus in a case of measuring X1 in a direction of the light source, and

wherein X2 is plus in a case of measuring X2 in a direction of the optical information recording medium with reference to the tangent plane and minus in a case of measuring X2 in a direction of the light source.

22. (Currently Amended) The optical pickup device of claim 21, wherein ~~in case that~~ $W(\lambda_0, T_0)$ is an RMS value of residual aberration of the objective lens when light having a wavelength of λ_0 (nm), which is a design wavelength thereof, is incident to the objective lens at an environmental temperature, which is a first ambient temperature T_0 = 25 °C, and

wherein $W(\lambda_0, T_1)$ is an RMS value of residual aberration of the objective lens when light having the wavelength of λ_0 (nm), which is a design wavelength thereof, is incident to the objective lens at the environmental temperature, which is a second ambient temperature T_1 = 55 °C,

ΔW defined by

$$\Delta W = |W(\lambda_0, T_1) - W(\lambda_0, T_0)| \qquad (3)$$

satisfies a following formula:

$$\Delta W < 0.035\ \lambda\text{rms} \qquad (4)$$

23. (Currently Amended) The optical pickup device of claim 21, wherein the design wavelength λ_0 of the optical objective lens is not more than 500 nm, ~~and in case that~~

wherein $fB(\lambda_0, T_0)$ is a back focal length of the objective lens when light having a wavelength of λ_0 (nm) is incident to the objective lens at an environmental temperature, which is a first ambient temperature $T_0 = 25$ °C, and

wherein $fB(\lambda_1, T_0)$ is a back focal length of the objective lens when light having a wavelength of λ_1 (nm), which is 5 nm longer than the wavelength of λ_0, is incident to the objective lens at the environmental temperature, which is the first ambient temperature $T_0 = 25$ °C,

ΔfB defined by

$$\Delta fB = |fB(\lambda_1, T_0) - fB(\lambda_0, T_0)| \qquad (5)$$

satisfies a following formula:

$$\Delta fB < 0.001 \text{ mm} \qquad (6)$$

24. (Previously Presented) The optical pickup device of claim 21, wherein the objective lens is an objective lens of a finite conjugate type for converging a diverging light beam emitted from the light source to the information recording surface of the optical information recording medium and satisfies a following formula:

$$0.8 > f > 0.2 \qquad (6A)$$

25. (Original) The optical pickup device of claim 24, wherein m satisfies a following formula when m is an image formation magnification of the objective lens:

$$0.2 > |m| > 0.02 \qquad (6B)$$

26. (Previously Presented) The optical pickup device of claim 24, wherein the objective lens and the light source are united by an actuator at least to be driven for tracking.

27. (Currently Amended) An optical pickup device, comprising:

a light source; and

a converging optical system including an objective lens for converging a light beam emitted from the light source to an information recording surface of an optical information recording medium,

wherein the optical pickup device is capable of recording and/or reproducing information by converging the light beam emitted from the light source to the information recording surface of the optical information recording medium with the converging optical system,

wherein the objective lens is a plastic single lens that comprises a ring-shaped phase structure on at least one optical surface, the ring-shaped phase structure comprising a plurality of ring surfaces and formed so that adjacent ring surfaces generate a predetermined optical path difference for incident light, and satisfies following formulas:

$$NA \geq 0.8 \qquad (7)$$

$1.3 > f > 0.2$ (8)

$500 \geq \lambda_0 \geq 350$ (15)

where NA is an image-side numerical aperture of the objective lens, which is required for recording and/or reproducing information for the optical information recording medium, [[and]] f (mm) is a focal length of the objective lens, and λ_0 (nm) is a design wavelength of the objective lens,.

wherein the optical device satisfies the following formulas:

$0.8 < d/f < 1.8$ (14)

$0.40 \leq (X1 - X2) \cdot (N - 1)/(NA \cdot f \cdot \sqrt{(1 + |m|)}) \leq 0.63$ (16)

where d (mm) is a lens thickness in an optical axis of the objective lens, X1 (mm) is a distance in an optical axis direction between a plane that is perpendicular to an optical axis and tangent to a top of an optical surface on a light source side and an optical surface on the light source side in a most peripheral portion of an effective diameter (position of the NA on a surface on the light source side to which a marginal light beam is incident), X2 (mm) is a distance in an optical axis direction between a plane that is perpendicular to an optical axis and tangent to a top of an optical surface on an optical information recording medium side and an optical surface on the optical information recording medium side in a most peripheral portion of an effective diameter (position of the NA on a surface on the optical information recording medium side to which a marginal light beam is incident), N is a refractive index of the objective lens at the design wavelength λ_0, and m is an image formation magnification of the objective lens,

wherein X1 is a plus in a case of measuring X1 in a direction of the optical information recording medium with reference to the tangent plane, and minus in a case of measuring X1 in a direction of the light source, and

wherein X2 is plus in a case of measuring X2 in a direction of the optical information recording medium with reference to the tangent plane and minus in a case of measuring X2 in a direction of the light source.

28. (Currently Amended) The optical pickup device of claim 27, wherein the ring-shaped phase structure is a diffraction structure having a function for diffracting predetermined incident light, and the objective lens ~~forms a converging wave front which is converged on the information recording surface owing to an effect obtained by combining a diffraction effect and a refraction effect~~ has a spherical aberration characteristic that spherical aberration changes in an undercorrected direction when a wavelength of the incident light changes to a longer wavelength.

29. (Cancelled)

30. (Currently Amended) The optical pickup device of claim 28, wherein [[when]] an optical path difference added to a wave front transmitted through the diffraction structure is denoted by an optical path difference function Φ_b defined by

$$\Phi_b = b_2 \cdot h^2 + b_4 \cdot h^4 + b_6 \cdot h^6 + \ldots$$

(wherein b_2, b_4, b_6... are 2nd-order, 4th-order, 6th-order... optical path difference function coefficients, respectively), a following formula is satisfied:

$$-70 < (b_4 \cdot h_{MAX}^4)/(f \cdot \lambda_0 \cdot 10^{-6} \cdot (NA \cdot (1-m))^4) < -20 \qquad (8A)$$

wherein λ_0 (nm) is a design wavelength of the objective lens, h_{MAX} is an effective diameter maximum height (mm) of the optical surface on which the diffraction structure is formed, and m is an image formation magnification of the objective lens.

31. (Cancelled)

32. (Currently Amended) The optical pickup device of claim [[31]] 27, wherein when a ring surface including an optical axis is called a central ring surface, a ring surface adjacent to an outside of the central ring surface is formed to be displaced in the optical axis direction so as to have a shorter optical path length than the central ring surface, and a ring surface at a maximum effective diameter position is formed to be displaced in the optical axis direction so as to have a longer optical path length than an ring surface adjacent to an inside thereof~~, and a ring surface at a position of 75% of a maximum effective diameter is formed to be displaced so as to have a shorter optical path length than a ring surface adjacent to an inside thereof and a ring surface adjacent to an outside thereof~~.

33. (Currently Amended) The optical pickup device of claim [[31]] 32, wherein a total of the ring surfaces is from 3 to 20.

34. (Currently Amended) The optical pickup device of claim [[31]] 32, wherein when Δ_j (μm) is a step amount of an arbitrary step of steps in the optical axis direction at a boundary of mutually adjacent ring surfaces in a ring-shaped phase structure formed in a region from a height of 75% to a height of 100% of an effective diameter maximum height of the optical surface on which the ring-shaped phase structure is formed and n is a refractive index of the objective lens at a design wavelength of λ_0 (nm), m_j represented by

$$m_j = INT(X) \qquad (8B)$$

(wherein $X = \Delta_j \cdot (n-1)/(\lambda_0 \cdot 10^{-3})$ and INT(X) is an integer obtained by half adjust of [[(X)]] X and is an integer not less than 2.

35. (Currently Amended) The optical pickup device of claim 27, wherein ~~in case that~~ $W(\lambda_0, T_0)$ is an RMS value of residual aberration of the objective lens when light having a wavelength of λ_0 (nm), which is a design wavelength thereof, is incident to the objective lens at an environmental temperature, which is a first ambient temperature T_0 = 25 °C,

wherein $W(\lambda_1, T_0)$ is an RMS value of residual aberration of the objective lens when light having a wavelength of λ_1 (nm), which is 5 nm longer than the wavelength of λ_0, is incident to the objective lens at the environmental temperature, which is the first ambient temperature T_0 = 25 °C, and

wherein $W(\lambda_2, T_1)$ is an RMS value of residual aberration of the objective lens when light having a wavelength of λ_2 (nm) is incident to the objective lens at the environmental temperature, which is a second ambient temperature $T_1 = 55\ ^{\circ}C$,

$\Delta W1$ and $\Delta W2$ defined by

$$\Delta W1 = |W(\lambda_2, T_1) - W(\lambda_0, T_0)| \qquad (9)$$

$$\Delta W2 = |W(\lambda_1, T_0) - W(\lambda_0, T_0)| \qquad (10)$$

satisfy following formulas:

$$\Delta W1 < 0.035\ \lambda rms \qquad (11)$$

$$\Delta W2 < 0.035\ \lambda rms \qquad (12)$$

wherein

when $\lambda_0 < 600$ nm, $\lambda_2 = \lambda_0 + 1.5$ (nm), and

when $\lambda_0 \geq 600$ nm, $\lambda_2 = \lambda_0 + 6$ (nm).

36. (Original) The optical pickup device of claim 35, wherein the optical pickup device satisfies a following formula:

$$\sqrt{((\Delta W1)^2 + (\Delta W2)^2)} < 0.05\ \lambda rms \qquad (13)$$

37. (Previously Presented) The optical pickup device of claim 27, wherein the objective lens is an objective lens of a finite conjugate type for converging a diverging light beam emitted from the light source on the information recording surface and satisfies a following formula:

$$1.1 > f > 0.2 \qquad (13A)$$

38. (Original) The optical pickup device of claim 37, the optical pickup device satisfies a following formula:

$$0.2 > |m| > 0.02 \qquad (13B)$$

where m is an image formation magnification of the objective lens.

39. (Previously Presented) The optical pickup device of claim 37, wherein the objective lens and the light source are united by an actuator at least to be driven for tracking.

40-42. (Cancelled)

43. (Currently Amended) An optical information recording/reproducing apparatus, the apparatus ~~comprising~~ including an optical pickup device that comprises:

a light source; and

a converging optical system including an objective lens for converging a light beam emitted from the light source to an information recording surface of an optical information recording medium, [[and]]

wherein the apparatus is capable of recording and/or reproducing information by converging the light beam emitted from the light source to the information recording surface of the optical information recording medium with the converging optical system,

wherein the objective lens is a plastic single lens and satisfies following formulas:

$$NA \geq 0.8 \qquad (1)$$

$$1.0 > f > 0.2 \qquad (2)$$

$500 \geq \lambda_0 \geq 350$ (15)

where NA is an image-side numerical aperture of the objective lens, which is required for recording and/or reproducing information for the optical information recording medium, [[and]] f (mm) is a focal length of the objective lens, and λ_0 (nm) is a design wavelength of the objective lens,

wherein the apparatus satisfies the following formulas:

$0.8 < d/f < 1.8$ (14)

$0.40 \leq (X1 - X2) \cdot (N - 1)/(NA \cdot f \cdot \sqrt{(1 + |m|)}) \leq 0.63$ (16)

where d (mm) is a lens thickness in an optical axis of the objective lens, X1 (mm) is a distance in an optical axis direction between a plane that is perpendicular to an optical axis and tangent to a top of an optical surface on a light source side and an optical surface on the light source side in a most peripheral portion of an effective diameter (position of the NA on a surface on the light source side to which a marginal light beam is incident), X2 (mm) is a distance in an optical axis direction between a plane that is perpendicular to an optical axis and tangent to a top of an optical surface on an optical information recording medium side and an optical surface on the optical information recording medium side in a most peripheral portion of an effective diameter (position of the NA on a surface on the optical information recording medium side to which a marginal light beam is incident), N is a refractive index of the objective lens at the design wavelength λ_0, and m is an image formation magnification of the objective lens,

wherein X1 is a plus in a case of measuring X1 in a direction of the optical information recording medium with reference to the tangent plane, and minus in a case of measuring X1 in a direction of the light source, and

wherein X2 is plus in a case of measuring X2 in a direction of the optical information recording medium with reference to the tangent plane and minus in a case of measuring X2 in a direction of the light source.

44. (Currently Amended) The optical information recording/reproducing apparatus of claim 43, wherein ~~in case that~~ $W(\lambda_0, T_0)$ is an RMS value of residual aberration of the objective lens when light having a wavelength of λ_0 (nm), which is a design wavelength thereof, is incident to the objective lens at an environmental temperature, which is a first ambient temperature T_0 = 25 °C, and

wherein $W(\lambda_0, T_1)$ is an RMS value of residual aberration of the objective lens when light having the wavelength of λ_0 (nm), which is a design wavelength thereof, is incident to the objective lens at the environmental temperature, which is a second ambient temperature T_1 = 55 °C,

ΔW defined by

$$\Delta W = |W(\lambda_0, T_1) - W(\lambda_0, T_0)| \qquad (3)$$

satisfies a following formula:

$$\Delta W < 0.035\ \lambda\mathrm{rms} \qquad (4)$$

45. (Currently Amended) The optical information recording/reproducing apparatus of claim 43, wherein the design wavelength λ_0 of the optical objective lens is not more than 500 nm, ~~and in case that~~

wherein $fB(\lambda_0, T_0)$ is a back focal length of the objective lens when light having a wavelength of λ_0 (nm) is incident to the objective lens at an environmental temperature, which is a first ambient temperature T_0 = 25 °C, and

wherein $fB(\lambda_1, T_0)$ is a back focal length of the objective lens when light having a wavelength of λ_1 (nm), which is 5 nm longer than the wavelength of λ_0, is incident to the objective lens at the environmental temperature, which is the first ambient temperature T_0 = 25 °C,

ΔfB defined by

$$\Delta fB = |fB(\lambda_1, T_0) - fB(\lambda_0, T_0)| \quad (5)$$

satisfies a following formula:

$$\Delta fB < 0.001 \text{ mm} \quad (6)$$

46. (Previously Presented) The optical information recording/reproducing apparatus of claim 43, wherein the objective lens is an objective lens of a finite conjugate type for converging a diverging light beam emitted from the light source to the information recording surface of the optical information recording medium and satisfies a following formula:

$$0.8 > f > 0.2 \quad (6A)$$

47. (Original) The optical information recording/reproducing apparatus of claim 46, wherein m satisfies a following formula when m is an image formation magnification of the objective lens:

$$0.2 > |m| > 0.02 \qquad (6B)$$

48. (Previously Presented) The optical information recording/reproducing apparatus of claim 46, wherein the objective lens and the light source are united by an actuator at least to be driven for tracking.

49. (Currently Amended) An optical information recording/reproducing apparatus, comprising:

an optical pickup device;

wherein the optical pickup device ~~comprises:~~ includes

a light source; and

a converging optical system including an objective lens for converging a light beam emitted from the light source to an information recording surface of an optical information recording medium, [[and]]

wherein the optical pickup device ~~is capable of recording~~ records and/or ~~reproducing~~ reproduces information by converging the light beam emitted from the light source to the information recording surface of the optical information recording medium with the converging optical system,

wherein the objective lens is a plastic single lens that comprises a ring-shaped phase structure on at least one optical surface, the ring-shaped phase structure

comprising a plurality of ring surfaces and formed so that adjacent ring surfaces generate a predetermined optical path difference for incident light, and satisfies following formulas:

$NA \geq 0.8$ (7)

$1.3 > f > 0.2$ (8)

$\underline{500 \geq \lambda_0 \geq 350}$ (15)

where NA is an image-side numerical aperture of the objective lens, which is required for recording and/or reproducing information for the optical information recording medium, [[and]] f (mm) is a focal length of the objective lens, and λ_0 (nm) is a design wavelength of the objective lens,

wherein the apparatus satisfies the following formulas:

$\underline{0.8 < d/f < 1.8}$ (14)

$\underline{0.40 \leq (X1 - X2) \cdot (N - 1)/(NA \cdot f \cdot \sqrt{(1 + |m|)}) \leq 0.63}$ (16)

where d (mm) is a lens thickness in an optical axis of the objective lens, X1 (mm) is a distance in an optical axis direction between a plane that is perpendicular to an optical axis and tangent to a top of an optical surface on a light source side and an optical surface on the light source side in a most peripheral portion of an effective diameter (position of the NA on a surface on the light source side to which a marginal light beam is incident), X2 (mm) is a distance in an optical axis direction between a plane that is perpendicular to an optical axis and tangent to a top of an optical surface on an optical information recording medium side and an optical surface on the optical information recording medium side in a most peripheral portion of an effective diameter (position of the NA on a surface on the optical information recording medium side to

which a marginal light beam is incident), N is a refractive index of the objective lens at the design wavelength λ_0, and m is an image formation magnification of the objective lens,

wherein X1 is a plus in a case of measuring X1 in a direction of the optical information recording medium with reference to the tangent plane, and minus in a case of measuring X1 in a direction of the light source, and

wherein X2 is plus in a case of measuring X2 in a direction of the optical information recording medium with reference to the tangent plane and minus in a case of measuring X2 in a direction of the light source.

50. (Currently Amended) The optical information recording/reproducing apparatus of claim 49, wherein the ring-shaped phase structure is a diffraction structure having a function for diffracting predetermined incident light and the objective lens has a spherical aberration characteristic that spherical aberration changes in an undercorrected direction when a wavelength of the incident light changes to a longer wavelength ~~forms a converging wave front which is converged on the information recording surface owing to an effect obtained by combining a diffraction effect and a refraction effect~~.

51. (Cancelled)

52. (Currently Amended) The optical information recording/reproducing apparatus of claim 50, wherein [[when]] an optical path difference added to a wave front transmitted through the diffraction structure is denoted by an optical path difference function Φ_b defined by

$$\Phi_b = b_2 \cdot h^2 + b_4 \cdot h^4 + b_6 \cdot h^6 + \ldots$$

(wherein b_2, b_4, b_6... are 2nd-order, 4th-order, 6th-order... optical path difference function coefficients, respectively), a following formula is satisfied:

$$-70 < (b_4 \cdot h_{MAX}^4)/(f \cdot \lambda_0 \cdot 10^{-6} \cdot (NA \cdot (1-m))^4) < -20 \qquad (8A)$$

wherein λ_0 (nm) is a design wavelength of the objective lens, h_{MAX} is an effective diameter maximum height (mm) of the optical surface on which the diffraction structure is formed, and m is an image formation magnification of the objective lens.

53. (Cancelled)

54. (Currently Amended) The optical information recording/reproducing apparatus of claim [[53]] 49, wherein when a ring surface including an optical axis is called a central ring surface, a ring surface adjacent to an outside of the central ring surface is formed to be displaced in the optical axis direction so as to have a shorter optical path length than the central ring surface, and a ring surface at a maximum effective diameter position is formed to be displaced in the optical axis direction so as to have a longer optical path length than an ring surface adjacent to an inside thereof~~, and a ring surface at a position of 75% of a maximum effective diameter is formed to be~~

~~displaced so as to have a shorter optical path length than a ring surface adjacent to an inside thereof and a ring surface adjacent to an outside thereof~~.

55. (Currently Amended) The optical information recording/reproducing apparatus of claim [[53]] <u>54</u>, wherein a total of the ring surfaces is from 3 to 20.

56. (Currently Amended) The optical information recording/reproducing apparatus of claim [[53]] <u>54</u>, wherein when Δ_j (μm) is a step amount of an arbitrary step of steps in the optical axis direction at a boundary of mutually adjacent ring surfaces in a ring-shaped phase structure formed in a region from a height of 75% to a height of 100% of an effective diameter maximum height of the optical surface on which the ring-shaped phase structure is formed and n is a refractive index of the objective lens at a design wavelength of λ_0 (nm), m_j represented by

$$m_j = INT(X) \qquad (8B)$$

(wherein $X = \Delta_j \cdot (n-1)/(\lambda_0 \cdot 10^{-3})$) and INT(X) is an integer obtained by half adjust of [[(X)]] <u>X and</u> is an integer not less than 2.

57. (Currently Amended) The optical information recording/reproducing apparatus of claim 49, wherein ~~in case of~~ $W(\lambda_0, T_0)$ is an RMS value of residual aberration of the objective lens when light having a wavelength of λ_0 (nm)<u>,</u> which is a design wavelength thereof<u>,</u> is incident to the objective lens at an environmental temperature<u>,</u> which is a first ambient temperature T_0 = 25 °C,

wherein $W(\lambda_1, T_0)$ is an RMS value of residual aberration of the objective lens when light having a wavelength of λ_1 (nm), which is 5 nm longer than the wavelength of λ_0, is incident to the objective lens at the environmental temperature, which is the first ambient temperature T_0 = 25 °C, and

wherein $W(\lambda_2, T_1)$ is an RMS value of residual aberration of the objective lens when light having a wavelength of λ_2 (nm) is incident to the objective lens at the environmental temperature, which is a second ambient temperature T_1 = 55 °C,

$\Delta W1$ and $\Delta W2$ defined by

$$\Delta W1 = |W(\lambda_2, T_1) - W(\lambda_0, T_0)| \quad (9)$$

$$\Delta W2 = |W(\lambda_1, T_0) - W(\lambda_0, T_0)| \quad (10)$$

satisfy following formulas:

$$\Delta W1 < 0.035\ \lambda rms \quad (11)$$

$$\Delta W2 < 0.035\ \lambda rms \quad (12)$$

wherein

when $\lambda_0 < 600$ nm, $\lambda_2 = \lambda_0 + 1.5$ (nm), and

when $\lambda_0 \geq 600$ nm, $\lambda_2 = \lambda_0 + 6$ (nm).

58. (Original) The optical information recording/reproducing apparatus of claim 57, wherein the apparatus satisfies a following formula:

$$\sqrt{((\Delta W1)^2 + (\Delta W2)^2)} < 0.05\ \lambda rms \quad (13)$$

59. (Previously Presented) The optical information recording/reproducing apparatus of claim 49, wherein the objective lens is an objective lens of a finite conjugate type for converging a diverging light beam emitted from the light source on the information recording surface and satisfies a following formula:

$$1.1 > f > 0.2 \quad (13A)$$

60. (Original) The optical information recording/reproducing apparatus of claim 59, wherein the apparatus satisfies a following formula when m is an image formation magnification of the objective lens:

$$0.2 > |m| > 0.02 \quad (13B)$$

61. (Previously Presented) The optical information recording/reproducing apparatus of claim 59, wherein the objective lens and the light source are united by an actuator at least to be driven for tracking.

62-64. (Cancelled)

65. (New) The objective lens for the optical pickup device of claim 11, wherein a ring surface at a position of 75% of a maximum effective diameter is formed to be displaced so as to have a shorter optical path length than a ring surface adjacent to an inside thereof and a ring surface adjacent to an outside thereof.

66. (New) The optical pickup device of claim 32, wherein a ring surface at a position of 75% of a maximum effective diameter is formed to be displaced so as to have a shorter optical path length than a ring surface adjacent to an inside thereof and a ring surface adjacent to an outside thereof.

67. (New) The optical information recording/reproducing apparatus of claim 54, wherein a ring surface at a position of 75% of a maximum effective diameter is formed to be displaced so as to have a shorter optical path length than a ring surface adjacent to an inside thereof and a ring surface adjacent to an outside thereof.